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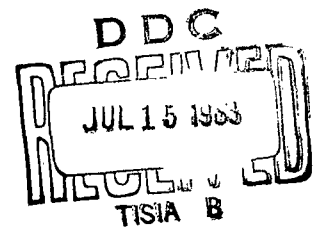
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SYSTEMS ANALYSIS AND URBAN PLANNING

Charles J. Zwick

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This morning we heard a discussion of the near-term potential of information systems to support a variety of urban functions. Although there was some disagreement among the panel members about approach, and the rate at which it is practical to proceed, the tone of the session was certainly optimistic, and this attitude, I believe, is appropriate. Important progress has been made in the last decade in the general field of information systems -- both in developing new hardware and with regard to systems design and development so that the new information hardware can be exploited in an urban planning context.

To practitioners in the general arena of urban affairs this development has major implications; a powerful tool is available to make it possible for you to do a

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better job. Since you have taken time out of your busy schedules to participate in these meetings, there is little reason for me to stress this point. As you know better than I, urban affairs are most complex. As a result, even small additions to our knowledge of the process that we are all trying to understand and to influence should have major payoffs.

My purpose is not, however, to add emphasis to what has been said this morning or will be presented in other sessions; rather, I want to focus on the development of new analysis techniques. New analysis techniques have been evolving in parallel with the growth of improved information systems technology. In fact, the two complement each other, and I am sure that they have stimulated each other's progress.

Looking at our growing information handling capability as if advances in this area have caused the development of new analysis techniques, the interrelationship is clear. With new data available and our ability to process them far exceeding the fondest expectations of research workers, it is not surprising that new analysis techniques came into being. Linear and dynamic programming are two such techniques that grew and were fostered in an environment of rapidly increasing ability to compute. Simulation models which

allow us to trace the dynamics of systems is another analysis technique that is highly dependent on new data processing technology. Also the availability of large amounts of information about a system, for example, a water, highway, or educational system, tends to stimulate research workers to use their new and exotic research methods on the problems of the system.

Clearly, growth in information technology has done much to stimulate the development of analysis techniques and the use of these techniques in specific areas. We are now witnessing a rapid growth of this sort of activity in the field of urban affairs. This is not because we have for the first time in history urban problems, but because a whole new body of data has become available, and urban problems are therefore susceptible to analytic study. There always have been, and hopefully always will be, competent research workers looking for new areas in which to practice their trade.

It is also true, however, that unsolved problems and new research techniques generate a requirement for new information and additional data processing capability, and therefore in a real sense cause some of the growth in new information technology. I will not speculate on which is

the chicken and which is the egg.

The important point is that practitioners in the general arena of urban affairs have not one, but several powerful new tools which should increase significantly their ability to carry out their individual responsibilities. My major objective is to sketch briefly the general characteristics of these new analysis techniques, and in doing this, I will try to show how they can complement your activities. I will also try to indicate what they will not do as there appears to be a great amount of current confusion on this subject. To stretch the point only slightly, there are some who seem to be saying that with an exotic research technique and a big computer we can solve any problem and do it almost instantaneously. This, of course, not only raises the specter of our being replaced by a machine, but by a machine so efficient that our previous efforts will be held in scorn. Apparently, for most of us, our remaining years will be unemployed and will be devoted to denying that we had anything to do with the incompetent activities that preceded the new enlightened era. In fact, a gentleman, who was formerly the director of a large urban research project and is now a professor of planning at one of our major universities, referred to these earlier efforts

as Pre-Darwinian. I am not sure what Pre-Darwinian means, but I am sure that few of us would feel comfortable with such a label attached to our work.

Let me spend the next few minutes commenting on these new research techniques; they are called by a variety of names in the literature, but one of the most common catch-all phrases is "systems analysis." What do we mean by systems analysis? Perhaps the one thing that characterizes a systems analysis is the attempt to fit an individual question or relationship into the bigger system of which it is a part. This focus or effort to embed a particular question into a larger context is fundamental to systems analysis.

Perhaps an illustration would be useful here. It has been traditional in transportation planning to base trip generation patterns on land-use projections. That is, given a projection of a future land-use pattern, a forecast of future trip-making behavior is made and this forecast is used, in turn, to plan future transportation facilities. It is now commonplace to point out that the creation of transportation facilities themselves may affect future land-use patterns, which in turn will affect one's forecast of future trip-making behavior, and to complete the circle, affect the need for transportation facilities.

Looking at this problem from a systems point of view, then, would mean that an attempt would be made to handle the feedback or interaction that exists between land-use and transportation facilities.

In brief, the essence of systems analysis is the recognition of interaction or feedback. Once this is accomplished, the next question to be faced is how to handle these interactions. In general terms there are two ways to handle the problem. They can be handled by creating a formal model which allows for the interactions or feedbacks, or by an ad hoc adjustment method. Let me illustrate these alternatives with the previous example of the interaction between land-use and the transportation system. One alternative would be to imbed the transportation sequence in a model of urban change -- that is, consider the transportation sequence as one part of the larger system of urban growth; a second approach would be to adjust directly the requirements that the transportation sequence generates. We know, for example, that if we build a limited-access highway or a rail rapid transit facility, we will cause some redistribution of land-use along the right-of-way. In general, the existence of the facility will attract activity and therefore generate additional traffic. The initial estimate should be adjusted upward to reflect this

impact. An ad hoc approach is quick and less complicated. It does, however, assume a knowledge of the underlying system so that correct "adjustments" can be made. When no adjustment is made to the initial traffic estimate, we are simply assuming a special case in which the interaction is zero.

Turning to the other alternative, namely, imbedding the transportation sequence in a model of urban growth, we can directly trace through the effects of the changes of the transportation system on land use. Given the new land-use pattern, we can then repeat the transportation sequence and derive a new set of transportation requirements. This procedure is repeated until the system settles down and we have a stable land-use pattern and a transportation system that matches the transportation requirements of the community.

The advantage of this more formal approach is quite apparent. We have a system of logic by which we can correct the original estimates of transportation requirements. This can be exposed to review; therefore, the validity of the adjustment process can be assessed. I believe that few would argue with this advantage. There are, however, several drawbacks to the more formal approach. First, even

with current and projected large-scale data processing technology, this is an expensive process and it is well to be concerned with the question of whether or not the expected benefits match or exceed the costs involved. Second, there is no guarantee that the approach will yield better estimates than a direct adjustment by ad hoc means of the transportation requirements that are derived from the first iteration of the transportation sequence. If the structure and parameters of the model are specified correctly, the approach should lead to unbiased estimates of the adjustment. But it is clear that the confidence that we place in the resulting estimates must be low as a large number of interactions are typically involved and many of these are stochastic or random in nature. At this point in time, we just do not know enough about many of the empirical relationships. A model cannot transform poor data and incorrectly specified relationships into valid results. Because of these considerations, the final results of a model of urban growth must necessarily be subject to a large amount of uncertainty.

Although it is not clear in the case just considered which of the two approaches is to be preferred, it is usually an attribute of the systems analysis to handle the

problem by formally modeling the system. In the case considered, this would take the form of imbedding the transportation sequence in a model of urban growth.

If we can recap for a moment, I have suggested that the systems analysis approach is one in which we fit an individual action or relationship into the bigger system of which it is part, and one in which there is a tendency to represent the system in a formal model. The advantages of this approach are clear. Unless feedback effects are taken into account, we may draw incorrect conclusions, and by formally modeling the system we provide a rigorous statement of the procedure that led to our conclusions. The analysis can be reproduced and this quality is very valuable in judging the soundness of particular conclusions.

On the other hand, the elaborateness of the formal model may not be worth the cost involved and could potentially mask logical errors. In the case of urban models, for example, we are concerned with abstracting the essential interrelationships of highly complex phenomena in the hope that if we confront the model with a specific environment or context, the model will behave in a manner that approximates the process of urban change in the real world. You all noted, I am sure, two key words

in the above -- namely, essential and approximates. Of the many, almost infinite interrelationships in any urban complex which are essential and therefore should be included in the model, how close a match must there be between the behavior of the model and the real world so that we can say the model approximates the real phenomena? These are important and unfortunately very difficult questions that must be answered by system analysts.

Finally, nothing has been said in all of this about the criteria by which to judge performance. Nothing in systems analysis guarantees that people will employ the right criteria in making judgments about appropriate courses of action. This is, as I am sure you all know, the really hard problem simply because there is no general agreement on appropriate criteria. Should we, for example, build a transportation system that minimizes the cost of handling a given number of ton-miles of freight, or one that will be consistent with a particular land-use pattern, which in turn someone feels is desirable, or should we allow the transportation system to evolve in response to changes in transportation technology and consumer preferences? To repeat, the question of appropriate criteria or goals is the most important of all the problems in drawing conclusions

with regard to appropriate public policy and there is nothing in the systems analysis approach which guarantees that this choice will be made wisely.

Systems analysis does, however, allow one to derive the logical implications of a set of initial premises. This approach, coupled with new analytic techniques and the rich body of data that is becoming available, as the result of the improving quality of our information systems, makes possible new insights into the complex processes of urban change. And this, I would argue, is a major advance in our ability to handle these problems in a responsible manner.

At this point it might be wise to stop and reflect on the usefulness of this new potential. I can see at least three uses for a systems analysis in urban planning. First, as an aid in forecasting. That is, to forecast how changes in particular variables will affect development of an urban complex. For example, how an urban renewal project, or how a new transportation system will affect the future course of the community. In this role the analysis would be in direct support of the planning function. A second use is that of a research tool to study the process of urban change. In this application, one is not interested in

forecasting the specific outcomes of given actions as a planner must. Rather one is interested in learning how sensitive the system is to change in different parameters. For example, is it true that we can cause major redistributions of land-use through the manipulation of the transportation system? The important distinction between this use and the forecasting objective is that we are interested in the analysis as a device to provide insights into the overall process rather than to forecasting specific outcomes with a given precision. As such, it will provide valuable background information to the planner, but will not provide him with specific forecasts. A third use of systems analysis is as an educational device. This objective differs from the second because it presumes you understand the underlying system and design the model or analysis so that certain interactions are highlighted. In this application the analysis serves as a demonstration device -- as a teaching aid, if you will.

In all of these roles, systems analysis can complement the role of the planner. Mel Webber, in speaking about the new land-use and traffic models said,

A growing excitement of discovery marks this tantalizing research, and for many it has taken on the appearance of the path to the city planner's green

pasture, but the real excitement is this: As we learn more about the constraining consistencies of urban form and function -- and then perhaps about the underlying reasons for these consistencies -- we should be able to identify the real range of future choice. If we can understand the limitations upon public choice, we can better identify the real opportunities for deliberately influencing the form of our future cities. And, as we narrow the margins of uncertainty, we can make more responsible recommendations to the political decision-makers whom we serve.*

As Professor Webber has indicated, the real excitement in the current growth of the analytical approach to urban problems is that it allows us to narrow the range of alternatives to those that are feasible. It provides a systematic means to assess the impact of technological and economic constraints. I have illustrated my talk by referring to transportation planning. Clearly the approach is applicable to a wide range of urban planning functions, for example, education and welfare facility planning; renewal activities; planning for police and fire protection, and so forth.

Hopefully, by this approach we can separate facts from goals in urban planning. I want to emphasize the need

*M. M. Webber, Editor's Preface, "Land Use and Traffic Models -- A Progress Report," Journal of The American Institute of Planners, Vol. XXV, No. 2, May, 1959.

for separating these two aspects of decision-making. It should be possible to establish with reasonable agreement basic economic and technological forces that are affecting our urban complexes. If this is possible, it will then also be possible to focus discussion on appropriate goals or criteria. And the planning profession, rooted as it is in the Utopian tradition, can concentrate its energies more effectively than it has in the past on making our urban communities increasingly desirable places for the conduct of human affairs. This, then, is the challenge and excitement of the current situation.

Thank you very much.